THURSDAY, OCTOBER 30, 1919.

EDUCATION AND LIFE.

Education for the Needs of Life: A Text-book in the Principles of Education. By Dr. I. E. Miller. (Home and School Series.) Pp. vii+353. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 7*s.* net.

BOOKS on education may be roughly divided into two classes—those to be read and those to be avoided. There need be no hesitation in placing Dr. Miller's work in the former class. It is designed chiefly as a text-book, but may be studied with profit by those who have long passed student days. It is a fresh and attractive restatement of the educational problem and its suggested solution. Education is conceived of as an integral phase of the life process; its task is to ascertain the child's vital needs and satisfactions, and to prepare him for their discharge or enjoyment, as the case may be. The starting-point is the biological adjustment to an environment. But adjustment is not mere passive moulding; it includes also dynamic response by the child. Nor does environment consist solely of the physical and material world; it embraces also mental, moral, social, æsthetic, and religious factors. The general treatment of the biological presuppositions occupies the first chapter, in the course of which it appears that the several elements involved are the aim of education, the child, the curriculum, methods, and the teacher. These, therefore, are the titles of the other five chapters.

Dr. Miller is a trained and sane psychologist, and his chapter on the child is an admirable epitome of our present knowledge of the stages of development up to adolescence, with hints for guidance in their treatment. Education must be functional; it must follow the child; it must wait upon development; it must catch the seasons of opportunity. The curriculum and the method must alike be organic to the pupil's capacities and requirements, and the teacher must by character and training be a person who can adapt himself to the varying situations which continually confront him. No mere structural or mechanical view satisfies the conditions of the problem, for any education deserving of the name must be subjective, not simply superposed. While the author would probably hesitate to subscribe to Rousseau's doctrine that the child should learn no lesson of which he does not see the present need, yet his theory seems to suggest that the appeal must always be through the consciousness of a felt want. He does, indeed, distinctly recognise the remote end—the needs of life; but as "two points determine a straight line," the present needs of the child and the destination in life are sufficient, he thinks, for the teacher's guidance and the pupil's well-being. But surely education is, like human progress in general, not a straight line. The analogy is rather that of zigzagging in a mountain ascent, or tacking on a voyage, where the goal is reached by humouring the gale, availing of the currents, and, above all, avoiding the shoals. Or, like the billiard player, the teacher may have to effect a cannon through a series of carefully calculated reactions along numerous lines, and with ultimate dual or multiple aim.

The volume bears evidence all through of the influence of Profs. Dewey, James, and other American writers, but Dr. Miller is by no means a slavish copyist. Among points of special merit are the treatment of imagination, the fundamental conception of the curriculum in its relation to life, and the plea for generous æsthetic culture based on psychological no less than on practical considerations. Dr. Miller writes out of the fullness of knowledge, first-hand acquaintance with the problems he discusses, and a belief in the efficacy of education which is an indispensable qualification of all workers in the field. But one would welcome a modification of expressions like "to gushingly remark" (p. 29), "to continually reconstruct" (p. 242), "run way beyond" (p. 292), and the like.

MATHEMATICAL TEXT-BOOKS.

(1) *Introductory Mathematical Analysis.* By Dr. W. Paul Webber and Prof. Louis Clark Plant. Pp. xiii+304. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 9*s.* 6*d.* net.

(2) *Descriptive Geometry.* By H. W. Miller. Revised in 1917 by the Department of General Engineering Drawing. Fourth edition. Pp. v+176. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 7*s.* net.

(3) *Premiers Eléments d'une Théorie du Quadrilatère Complet.* By A. Oppermann. Pp. 76+1 plate. (Paris: Gauthier-Villars et Cie, 1919.) Price 4 fr.

(1) THIS book contains the elements of algebra, trigonometry, analytical geometry, and infinitesimal calculus; it is apparently intended for first-year students at a university. The reviewer does not feel able to recommend the book; the reason for his opinions will be gathered from the following notes, which may be of use to the authors in the event of their having to prepare another edition:—

P. 122. It is tacitly assumed that complex numbers obey the ordinary laws of algebra; the assumption is pointed out in a footnote on p. 240.

P. 199. The proofs of the formulæ for the derivates of irrational and imaginary powers appear to assume what they profess to prove. Incidentally, imaginary powers do not seem to be defined anywhere in the book.

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P. 236. The exponential series is defined as the limit of $(1+x/n)^n$, and is denoted by e^x; on p. 237 it is taken for granted that e^x, so defined, obeys the laws of indices.

P. 241. The proof of Euler's exponential expressions for the sine and cosine is new to the reviewer, but he fails to see why the variable must be expressed in radians rather than in any other unit of angular measure. The fact that the authors tell us on three occasions (pp. 108, 147, 243) that angles must be given in radians scarcely seems an adequate reason.

We are told twice (pp. 22 and 29) that feet and inches are denoted by the symbols $'$ and $''$, but it is apparently considered superfluous to define a degree (until p. 106, though degrees are used on p. 41) or to give the details of sexagesimal measure, and the student is referred to the tables for the values of the trigonometrical functions of 30°, 45°, and 60°.

P. 63. A definition of "variable" is given, but no definition of "constant."

P. 91, ex. 10. To solve $\sin(x-25°)=0.6$ by using the addition theorem is a method which seems unnecessarily cumbrous.

P. 91, ex. 11. The equation $\arctan x = \operatorname{arc\,sec} x - 45°$ seems to lead to a cubic equation. Methods for solving cubics are not given until p. 144.

P. 182. The student should not be asked to prove that, in the hyperbola, $F'P-FP=2a$, without being told that the equation is true for one branch only.

P. 269. In a book which does not define even hyperbolic functions, it is going rather far to ask the student to find the length of $y=\sin x$ from $x=0$ to $x=\pi$.

Chap. xvii. The notations $\int f(x)$ and $\int f(x)dx$ seem to be used indifferently. The object of the former notation is not apparent. The notation "cot" used hitherto is here replaced by "ctn" without explanation.

Misprints and other minor errors have been noted at p. 35, ex. 17; p. 50, ex. 17; p. 69, l. 9; p. 106, l. 7 up; p. 116, ex. 9; p. 120, l. 2 up; p. 123, l. 2 up; p. 136, l. 21; p. 173, ex. 12; p. 180, ex. 6; p. 232, ll. 3, 4; p. 243, ll. 5, 7, and 8; p. 253, ex. 22; p. 263, l. 1; p. 271, ex. 2; p. 274, exs. 14, 21; p. 275, ex. 25; and p. 277, ex. 15.

(2) This work, which was first published in 1911, has now been revised by the author, with the assistance of six of his colleagues. It forms an admirable introduction to the subject for the student, and deserves very high commendation. The mode of presentation has been carefully thought out, with the result that the style is clear and lucid, and any student of ordinary intelligence should be able to get from the book a sound knowledge of the subject without the aid of a teacher.

The first chapter contains a synopsis of the notations used in the book; then follow four chapters on the representations of points and lines by elevation and plan, and of planes by their traces; next there are four chapters on curved surfaces—mainly cones, cylinders, and spheres—a useful chapter on shadows, and a brief account of perspective. These chapters contain numerous practical problems, each worked out in full with enunciation, discussion, analysis, and construction. The book concludes with a collection of eight long papers of problems and a good index. The diagrams are clear and well-proportioned, though a few of them would have been improved by being made rather larger.

The reviewer would like to make a few minor suggestions for the improvement of future editions. In the first place, the student may be a little puzzled at finding that the "profile-plane" plays a subordinate part compared with the other two co-ordinate planes (*e.g.* it is not mentioned in § 19 on the "alphabet" of a point), and the explanation of this would be useful. Also, the terms "profile ground-line" (§ 13) for a line which is not horizontal, and "vertical of a plane" (§ 42) for a line which is not vertical, seem somewhat misleading.

Two omissions must be mentioned. The first is that no use is made of the method of changing the co-ordinate planes—a method which gives an elegant solution of such a problem as finding the true length of a line, by taking a new vertical plane parallel to the plan of the line. The second omission is of rather more importance to the student; he would find the subject much more interesting and concrete if some work (possibly in the form of examples) on solids with plane faces were included. The reviewer well remembers how fascinated he used to be by drawing cubes and pyramids in fantastic positions, particularly if a section of the solid had also to be drawn.

The book would have been enhanced in value to the student of crystallography if some account of isometric projection had been given, and the reviewer would have been glad to see some developments of the theory of perspective—*e.g.* the theorem that plane figures in perspective remain in perspective when rotated about their axis of collineation; but possibly the author considers that such additions would have unduly increased the size of the book.

(3) In this, an interesting and suggestive work, the author (an engineer) discusses the theory of the quadrilateral after the manner in which various modern geometers have discussed the triangle. The treatment is quite elementary, and the object of the author is not to give a complete discussion of the subject, but to encourage and facilitate research. The book, "publié au moment où la France vient de reconquérir les provinces qui lui ont été arrachées en 1871," is dedicated to the memory of Joseph Pruvost, professor of mathematics at Strasbourg until the annexation; it contains a useful bibliography—a feature hitherto somewhat rare in mathematical works published in France.

MINERAL RESOURCES OF GEORGIA.

Mineral Resources of Georgia and Caucasia: Manganese Industry of Georgia. By D. Ghambashidze. Pp. 182. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1919.) Price 8*s.* 6*d.* net.

THIS little book is interesting as being the outcome of the reorganisation of national boundaries after the war and as evidence of the political and economic independence of the new Republic of Georgia; this was an independent kingdom until it was forcibly annexed by Russia in 1801, and only recommenced its autonomous existence in 1917. The object of the work now published by Mr. Ghambashidze is to make British readers acquainted with the industrial importance of Georgia and Caucasia so far as the mineral wealth of this region is concerned. The author gives a long list of the various mineral substances of economic value known to occur therein, although relatively few have been worked on an industrial scale.

The oilfields of Caucasia have long been known, the principal field, that of Baku, having been for many years one of the world's great producers, with an annual (pre-war) output of about 7 million tons of petroleum. Next in importance comes that of Grozny, with a production of 1–1½ million tons, and there are also several smaller ones, the output from which is at present negligible; even the Maikop field, the first borings in which aroused so much excitement, has sunk to a quite unimportant factor in the general production. Of the other non-metallic minerals, bitumen is at present the most important, though the sulphur deposits in the province of Erivan, 30 miles from a railway line, may prove to be of value in the near future.

Of the metallic minerals, a few deposits of iron-ore are known, but none apparently of great importance. There are several known deposits of blende and galena, but only one, a mine at Sadon, is being worked at present; it is in the hands of a Russo-Belgian company, the Société Minière et Chimique Alagir. Copper is abundant and has been worked in many parts of Georgia and Caucasia. The best known of all is the Kedabek mine at Mis-Dag, which was an important producer up to about 1912, when the deposits began to show signs of exhaustion, so that the present output is barely 100 tons of copper per annum, whereas it was at one time up to 1750 tons. Altogether there were in 1914 some twenty-eight copper mines at work, fourteen of which had their own smelters; the total production of copper in 1914 was 8259 tons. The most important of the metalliferous minerals is manganese ore. In addition to a number of deposits in various parts of Georgia, which are not being worked at present, and are briefly referred to, the well-known deposits in the province of Kutais, which cover an area of 400 square miles and are estimated to contain 200 million tons of available ore, are described in some detail. The exports of this ore from Georgia had reached more than a million tons in 1913, but then fell off rapidly owing to the war. There appears to be no reason why this industry should not again recover its previous importance. The book contains a valuable amount of statistical information carefully tabulated, showing the mineral production of the districts treated of, and should be of use to all engaged in the mineral industry of the Near East.

H. L.

OUR BOOKSHELF.

A Simple and Rapid Method of Tide Prediction. (Including Diurnal Time and Height Inequalities.) By Sgt. M. E. J. Gheury. Pp. 53. (London: J. D. Potter, 1919.) Price 5*s.*

IN this little book the author explains the method which he developed for predicting the time and height of high and low water at Richborough, on the River Stour (Kent). From observations of these variables, extending over a fortnight only (in the first instance), it proved possible to deduce satisfactory predictions with but little trouble. The method has a rational basis, which is described in a preliminary account of the tide-producing forces and their variations. The work involved is partly graphical and partly tabular, but no harmonic analyses are required. The aim is to replace the unsatisfactory method by which a set of corrections is applied to the high- and low-water data for the nearest standard port, which at some stations may be as much as 200 miles away. In the present case the nearest standard port was only 20 miles away (Dover), but even in this instance Mr. Gheury's method, applied to deduce times of high water, gave better results than did the application of a correction to the elaborately derived Dover data. Richborough, being situated several miles up a narrow and sinuous tidal stream opening in a bay, presents some rather complex tidal features, including well-marked diurnal height and time inequalities; the success of the method, which can readily be applied to other similar or simpler stations, is therefore the more significant. The book is marred by some irritating misprints and grammatical errors, but the explanations are, on the whole, correct and lucid.

Fermat's Last Theorem: Three Proofs by Elementary Algebra. By M. Cashmore. Revised edition. Pp. 55. (London: G. Bell and Sons, Ltd., 1918.) Price 2*s.* 6*d.* net.

IT is unfortunate that F. P. Wolfkehl's legacy of a prize for settling the vexed question of "Fermat's Last Theorem" should have stimulated such a large erroneous mathematical literature. Most of the publications pretending to prove the theorem are deplorable for at least three reasons: first, because many of their authors have had insufficient mathematical training to enable them to decide whether a supposed proof is sound or not; secondly, because of the expense incurred by the authors in printing invalid proofs; and

thirdly, because useless publications increase the burden of librarians and scholars. We are far from wishing to discourage genuine attempts to reproduce Fermat's line of thought. In view of the state of mathematical knowledge 250 years ago, Fermat's proof, assuming it to be correct—a point on which expert opinions differ—is as likely to be discovered by a clever schoolboy of seventeen as by a more highly trained mathematician.

Mr. Cashmore, in the tract before us, presents three distinct "proofs," all erroneous. In I. (p. 14) he states that when

$$ax^2+by^2=w^n, \text{ then } w=au^2+bv^2,$$

the letters denoting ordinary integers. A numerical example is enough to show that this is erroneous; thus

$$2^2+5\cdot1^2=3^2, \quad 11\cdot2^2+9^2=5^3;$$

but there are no integral solutions of

$$x^2+5y^2=3, \quad 11x^2+y^2=5.$$

The first of several fallacies in II. occurs on p. 26, and in III. (p. 43) Mr. Cashmore states that when $(p^n-q^n)y^{n-1}$ is divisible by pq, then y is divisible by pq, it being assumed that p and q are integers with no common factor It is seen that this deduction is erroneous by taking

$$p=9, \ q=4, \ y=6, \ n=3.$$

W. E. H. B.

Secrets of Animal Life. By Prof. J. Arthur Thomson. Pp. viii+324. (London: Andrew Melrose, Ltd., 1919.) Price 7*s.* 6*d.* net.

THIS is a collection of forty essays, contributed during recent years by Prof. Thomson to the *New Statesman*, and now collected in a handy and attractive volume. In his own clear and charming style the author seeks "to interest thoughtful readers in the multitudinous problems of animal life," and he wisely enforces the lesson that, in many cases, the solutions of these problems are "secrets" still. Such familiar subjects as the habits of rooks and cuckoos or the "Fall of the Year" are mixed with review-summaries of noteworthy recent zoological literature of general interest such as Watson and Lashley's observations on the "homing" of terns, Emery's researches on the habits of Amazon ants, or Petersen's surveys of the Zostera-beds off the coasts of Denmark. The problems of inheritance and evolution are prominent, as might be expected, and from such papers as "With Darwin Forwards" and "The Mendelian Clue," the "thoughtful reader" may gain a clear introductory view of the fields of biological inquiry, as well as guidance in the way of deeper study. Prof. Thomson never misleads those for whom he writes by implying that after reading him they have no more to learn; his treatment of "The Problem of Cave Blindness," for example, affords a needed corrective to widespread dogmatism on a subject that has appealed to popular imagination since the early days of evolutionary biology. G. H. C.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

International Relations in Science.

I DO not agree with the proposals made by Prof. D'Arcy Thompson in NATURE of October 23. I think that the less our academies and societies move in this matter the better. For my own part I objected altogether to the proposal made during the war to strike off our records the names of distinguished men of enemy nationality who had been elected "foreign members" before the war. They had not been admitted to any power or rights in consequence of that election, and it was, in my judgment, futile and petty to endeavour to obliterate the record of the honour which had been justly accorded to them.

As to making overtures to, and the reception of overtures from, the academies of those hostile nationalities with which peace is not yet ratified, it seems to me that our own societies and academies should at present neither offer nor accept any such overtures. They are mere formalities and demonstrations without any real significance or value, and must be, and are often designed to be, misleading. On the other hand, I think every individual should act according to his own feeling and judgment, and not according to mass sentiment, in regard to entering into friendly relations with German men of science. At present I personally could not accept such relations. I wish to reserve all action in the matter until my memory of many things has faded. But I will never wittingly treat even those whom I most dislike with less than justice tempered by generosity.

E. RAY LANKESTER.

The Response of Plants to Wireless Stimulation.

A GROWING plant bends towards light; this is true, not only of the main stem, but also of its branches and attached leaves and leaflets. This movement in response is described as the tropic effect of light. Growth itself is modified by the action of light: two different effects depending on the intensity are produced; strong stimulus of light causes a diminution of rate of growth, but very feeble stimulus induces an acceleration of growth. The tropic effect is very strong in the ultra-violet region of the spectrum with its extremely short wave-length of light; but the effect declines practically to zero as we move towards the less refrangible rays, the yellow and the red, with their comparatively long wave-length. As we proceed further in the infra-red region we come across the vast range of electric radiation, the wave-lengths of which vary from the shortest wave I have been able to produce (0·6 cm.) to others which may be miles in length. There thus arises the very interesting question whether plants perceive and respond to the long æther-waves, including those employed in signalling through space.

At first sight this would appear to be very unlikely, for the most effective rays are in the ultra-violet region with wave-length as short as 20×10^{-4} cm.; but with electric waves used in wireless signalling we have to deal with waves 50,000,000 times as long. The perceptive power of our retina is confined within the very narrow range of a single octave, the wave-lengths of which lie between 70×10^{-6} cm. and 35×10^{-6} cm. It is difficult to imagine that plants could perceive radiations so widely separated from each other as the visible light and the invisible electric waves.

But the subject assumes a different aspect when we

take into consideration the total effect of radiation on the plant. Light induces two different effects which may broadly be distinguished as external and internal. The former is visible as movement; the latter finds no outward manifestation, but consists of an "up" or assimilatory chemical change with concomitant increase of potential energy. Of the two reactions, then, one is dynamic, attended by dissimilatory "down" change; the other is potential, associated with the opposite "up" change. In reality, the two effects take place simultaneously; but one of them becomes predominant under definite conditions.

The modifying condition is the *quality* of light. With reference to this I quote the following from Pfeffer:—"So far as is at present known, the action of different rays of the spectrum gives similar curves in regard to heliotropic and phototactic movements, to protoplasmic streaming and movements of the chloroplastids, as well as the photonastic movements produced by growth or by changes of turgor. On the other hand, it is the less refrangible rays which are most active in photosynthesis."[1] The dynamic and potential manifestations are thus seen to be complementary to each other, the rays which induce photosynthesis being relatively ineffective for tropic reaction, and *vice versa*.

Returning to the action of electric waves, since they exert no photosynthetic action they might conceivably induce the complementary tropic effect. These considerations led me to the investigation of the subject fourteen years ago, and my results showed that very short electric waves induce a retardation of rate of growth; they also produce responsive movements of the leaf of Mimosa when the plant is in a highly sensitive condition.[2] The energy of the short electric waves is very feeble, and undergoes great diminution at a distance; hence the necessity for employment of a specimen of plant in a highly sensitive condition.

I resumed my investigations on the subject at the beginning of this year. I wished to find out whether plants in general perceived and responded to long æther-waves reaching them from a distance. The perception of the wireless stimulation was to be tested, not merely by the responsive movement of sensitive plants, but also by diverse modes of response given by all kinds of plants.

The Wireless System.

For sending wireless signals I had to improvise the following arrangement, more powerful means not being available. The secondary terminals of a moderate-sized Ruhmkorff's coil were connected with two cylinders of brass, each 20 cm. in length; the sparking took place between two small spheres of steel attached to the cylinders. One of the two cylinders was earthed and the other connected with the aerial 10 metres in height. The receiving aerial was also 10 metres in height, and its lower terminal led to the laboratory, and connected by means of a thin wire with the experimental plant growing in a pot; this latter was put in electric connection with the earth (Fig. 1). The distance between the transmitting and receiving aerial was about 200 metres, the maximum length permitted by the grounds of the institute.

I may state here that with the arrangement described above I obtained very definite mechanical and electric response to wireless impulse. For the former I employed the plant Mimosa; the latter effect was detected in all plants, sensitive and ordinary. Limitation of space will allow only a detailed description of the responsive modification of growth.[3]

[1] Pfeffer, "Physiology of Plants," vol. ii., p. 104.
[2] Bose, "Plant Response," p. 618. (1905.)
[3] A detailed account of the response of plants to wireless stimulation will be found in the Transactions of the Bose Institute, vol. ii., to be published in November, 1919.

Effect of Wireless Stimulation on Growth.

For the detection of variation of growth it was necessary to devise the extremely sensitive balanced crescograph. In this apparatus a compensating movement is given to the plant-holder by which the plant subsides exactly at the same rate as its growth-elongation, so that the tip of the plant remains at the same point. This perfect balance is attained by a variable regulator. The compound magnifying

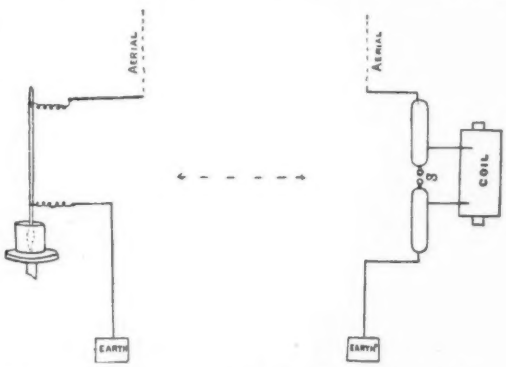

FIG. 1.—Diagrammatic representation of the method of wireless stimulation. On the right is seen the generating apparatus. The tip of the growing plant is connected with the receiving aerial, and the lower part or the flower-pot is earthed.

lever attached to the plant records the movement of growth. Under exact balance the record is horizontal. Any induced acceleration of growth would upset the balance, with a resulting down record; induced retardation, on the other hand, would cause an upset in the opposite direction and an up curve. The results given below show that growing plants not only perceive, but also respond to the stimulus of electric waves. These effects were found in all

FIG. 2.—Automatic records obtained with the balanced crescograph showing the effects of wireless stimulation on growth. (*a*) Feeble stimulus inducing acceleration; (*b*) strong stimulus inducing retardation of rate of growth; (*c*) series of growth responses by variation of growth due to uniform moderate stimulation. Up-curve represents retardation of growth and down-curve acceleration (seedling of wheat).

growing plants. The following records were obtained with the seedlings of wheat.

Effect of Feeble Stimulus.—Experiment 1: I first studied the effect of feeble stimulus. This was secured by decreasing the energy of sparks of the radiator. The response was an acceleration of rate of growth as seen in Fig. 2, (*a*). This is analogous to

the accelerating effect of light stimulation of subminimal intensity.

Effect of Strong Stimulus.—Experiment 2: The maximum energy radiated by my transmitter, as stated before, was only moderate. In spite of this, its effect on plants was exhibited in a very striking manner. The balance was immediately upset, indicating a retardation of the rate of growth. The latent period, *i.e.* the interval between the incident wave and the response, was only a few seconds (Fig. 2, (*b*)). The record given in the figure was obtained with the moderate magnification of 2000 times only; but with my crescograph the magnification can easily be raised ten million times, and the perception of plant to the space-signalling can be exalted in the same proportion.

Under an intensity of stimulus slightly above the subminimal, the response exhibits retardation of growth followed by quick recovery, as seen in the series of records given in Fig. 2, (*c*). The perceptive range of the plant is inconceivably greater than ours; it not only perceives, but also responds to the different rays of the vast æthereal spectrum. J. C. BOSE.

Calcutta, August 16.

A New British Enchytræid Worm.

IN a collection of worms brought from Lapworth by Mr. Hillman on August 11, I found one which is new to this country, and of great interest on account of its unusual character and relationships. In 1877 Vejdovsky described his *Pachydrilus sphagnetorum*. Eleven years later Michaelsen added to it a variety named *glandulosus*. In course of time the name Pachydrilus was changed to Marionina, and the two worms above-named were placed as distinct species under this genus, forming a section by themselves on account of their aberrance. They both had the girdle thrown forward, the spermathecæ were free in the cœlom, the septal glands were more numerous than in the type, and there were other peculiarities. In Michaelsen's "Oligochæta," published in 1900, they appear as *Marionina sphagnetorum*, Vejd., and *M. glandulosa*, Mich.

In 1913 I described a new British Enchytræid (*Chamaedrilus chlorophilus*, Friend), which could not be fitted into any then known genus. Its relationships were discussed and its affinities with the two aberrant Marioninas pointed out. On finding *M. glandulosa*, I was for a time in doubt about its true name, as it so closely resembled Chamædrilus. Careful study, however, shows that the three worms are very nearly related, and must be referred to one and the same genus. In Marionina the blood is slightly coloured, in Chamædrilus it is quite colourless. In the former the spermathecæ are free, whereas in Chamædrilus they are attached to the intestine. In all other respects they agree. The forward position of the girdle, the shape and number of the setæ, absence of salivary glands, form of spermathecæ, size of cœlomic corpuscles and chloragogen cells, enlarged number of septal glands, incised brain, and other important characters, all point to one genus.

They are exceedingly slender worms, and Vejdovsky has pointed out a peculiarity in *M. sphagnetorum* which is of special interest. Like certain water-worms, it can multiply by subdivision. We have here, very clearly, a genus which links the Enchytræids with some of the other families of worms. Details cannot be discussed now, but it is evident that we shall for the present have to regard the genus Chamædrilus as consisting in this country of three species, viz. *Chamaedrilus sphagnetorum*, Vejd., *C. glandulosus*, Mich., and *C. chlorophilus*, Friend. The generic characters are roughly as follows:—

CHAMÆDRILUS.—Girdle advanced to segment 10, 9, or 8; nephridia begin in 8/9 or 9/10; spermathecæ with posterior outgrowth, either free or attached to the intestine; cœlomic corpuscles and chloragogen cells large; blood colourless or but slightly tinged with yellow or red; the dorsal vessel originating behind the girdle and possessing no anterior commissures (apparently). Salivary gland absent, brain deeply incised. Related to Stercutus and Bryodrilus.

HILDERIC FRIEND.

"Cathay," Solihull, September 24.

A Photoelectric Theory of Colour Vision.

IN view of the recent letters from Prof. Joly and Sir Oliver Lodge under the above heading, I may be allowed to point out that such a theory of colour vision was advanced by me in a lecture delivered before the Röntgen Society on January 7 last, and published in the Journal of the society for April. After referring to Prof. Joly's views as to the nature of the change taking place in the formation of the latent image and in radio-therapy, I said: "In my opinion, it is unnecessary to assume that a photochemical change is the cause of the visual sensation. It appears to me sufficient to suppose that photoelectric action takes place in the rods or cones, so that we have a separation of electrons resulting in electrification of the nerve-cells which set up the nervous impulse to the sensorium." A number of familiar facts were adduced in support of this view, and it was mentioned that the peaked curve which shows the relation between the sensitiveness of the eye for light of different wave-lengths bears a very close resemblance to the curve which shows the variation of photoelectric activity with wave-length. H. STANLEY ALLEN.

Luminous Worms.

AROUND Nottingham forty-five years ago it was a common practice among anglers to search the meadows by aid of a lantern for "dew-worms and cockspurs," as they were locally known. After collection they were placed in damp moss in a dark shed for a few days until they were "scoured"; this brought them into condition, and rendered them more attractive as bait and fresher and redder in colour. After this treatment worms were phosphorescent for about one-fourth of the entire length of the body, while the light was most noticeable in the ventral region. H. E. ALDRIDGE.

40 Great Queen Street, Dartford.

RECONSTRUCTION.

IT has been a reproach, not without foundation, frequently cast at the British Empire that there has been hitherto a lack of reasonable and sufficient organisation. The circumstances arising out of a state of war have led necessarily to the institution of a number of new Departments which have been called into existence hastily and without adequate consideration. Some of these will, of course, disappear, and others will remain to be reconstituted. In view of these facts the Government did wisely in July, 1917, in appointing a Committee with the purpose of considering the changes which would become necessary after the war, and the report of one of its Sub-Committees, that on the Machinery of Government,

under the chairmanship of Lord Haldane, is now before us. This Sub-Committee was appointed "to inquire into the responsibilities of various Departments of the Central Executive Government and to advise in what manner the exercise and distribution by the Government of its functions should be improved." It is obvious that here is a field of inquiry which is necessarily very extensive and very complicated, and the report fills eighty octavo pages. We have already (April 3) dealt with some aspects of the report, but the subject is so important that no excuse is necessary for considering others now. One of the most striking declarations by the Sub-Committee is to be found very early in the report in reference to the formulation of policy, for the conclusion is reached that "the duty of investigation and thought, as preliminary to action, might with great advantage be more definitely recognised." In elaborating its remarks on the importance of distinguishing the business of inquiry and research from that of administration, it refers especially to the desirability of giving special attention to the methods of recruiting the *personnel* to be employed in the Departments charged with the duty of inquiry, research, and reflection before policy is defined and put into operation.

This is one of the questions concerning which there is room for criticism of the methods generally pursued in the past. Attention has been repeatedly directed to the neglect of physical and natural science in the qualifications demanded of every member of the higher branches of the Civil Service in this country. The effect of this neglect has been that it frequently happens that when a new Department is to be called into existence the men appointed to take charge of the work are deficient in knowledge of the facts, principles, and methods which should be employed in carrying out their duties, inasmuch as it is still the custom generally to select for these appointments Civil Servants whose good general characters as active and intelligent men are their only qualification. In a few cases, far too infrequent, appointments of this kind have been offered to men outside the Civil Service with special qualifications for the work contemplated. Such a post as that of the Government Chemist has necessarily been filled by an eminent outsider, and the Board of Agriculture has in several cases selected for posts in that Department men who have an established reputation in connection with problems relating to agricultural practice.

The remarks of the Sub-Committee on the necessity for collaboration among Departments so that all information collected by any one Department may be accessible to all the rest whenever it is required without waste of energy or time in re-collection are very appropriate, and it may be hoped will be acted upon.

To the readers of NATURE probably the contents of chap. iv. of the report, concerning research and information, will be found most interesting, and among the subjects dealt with in some detail is the work of the Medical Research Committee and of the Department of Scientific and Industrial Research. Both of these cover a wide field. The work of the former may be roughly divided into the study of questions connected with the National Health Insurance Acts on one hand, and general medical research on the other. Here, as in other directions, applications of science are subject to constant modification arising out of the discovery of new facts or principles. By way of illustration reference may be made to researches on food which are now being carried on. The discoveries which in very recent times have been made as to the existence in certain foodstuffs of the remarkable substances known as *vitamines* and their non-existence in others must lead to a modification of our views concerning the whole question of dietary and health. The exact nature of the vitamines is at present unknown, whether they consist of definite chemical, but hitherto unrecognised, substances, or whether they consist of mixtures of products of degradation of proteins. All that can be said is that the amount present in any case is minute. It is therefore not sufficient to determine roughly the composition of a given foodstuff and the proportion of fat, starch, or protein it may contain. Another line of work arises from the study of the question of the preservation of food by cold storage. It is now well known that the temperatures requisite in one case are not suitable in others; thus the cold required for meat and fish is not required for fruit, and even different kinds of fruit, such as plums and pears, cannot be shipped safely in the same chamber where slight differences of temperature may be found between the centre of the room and the walls.

The Department of Scientific and Industrial Research, the third annual report of which was noticed in NATURE of October 17, 1918, comes in for a good deal of discussion in the report before us. It will be remembered that this is a Department for which the Lord President of the Council (then Lord Crewe) was responsible, and was created with funds at its disposal for instituting (1) specific researches, (2) scientific research in connection with industry, and (3) the award of studentships or fellowships to assist in research. The sum of 1,000,000*l.* was granted for use in applying over an agreed period a special stimulus to industry. This fund is applied in making grants to approved trade associations for research to supplement the resources of the associations. Some difficulties have occurred in determining to whom the results of research undertaken by the respective associations belong, and it seems doubtful whether procedure through the agency of trade associations is likely in the long run to prove the best avenue to progress in the way of applying discovery to industry. At any rate, the claims of the individual researcher will have to be considered and provided for in each case.

Funds are also provided by an annual vote for the general purposes of the Department, and from this source assistance is given to other bodies and

other questions which may have only an indirect relation to particular industries or trades. The Fuel Research Board affords an example of the kind of work which may be undertaken with the aid of Government funds, and is now in active operation in connection with the South Metropolitan Gasworks. The inquiry is too costly and altogether beyond the means of such agencies as a British Association Committee or the private persons by whom the research was initiated.

But with regard to special scientific studies undertaken by individuals help is still urgently wanted, and the question arises whether such help can always be obtained from the Department so long as one of the conditions of a grant is that details of the research contemplated must be communicated to so large a number of persons as form an advisory council or board. Aids to research must be given in other ways. There seems to be some difference of opinion whether this would be best accomplished by increasing substantially the present grant of 4000*l.* per annum to the Royal Society, or by augmenting the annual grant to universities and other teaching institutions where teachers and students may co-operate in the work. The scientific worker is often shy of exposing his ideas in their early crude form to external criticism, and tentative preliminary inquiry should be provided for before the researcher is called on to expose the whole of his plan.

The whole scheme foreshadowed in this report shows and acknowledges in more than one passage the need for men. It has often been claimed for the Oxford classical system of education that it does select and equip with the necessary knowledge the young Englishmen whose destiny it is to become administrators. The Oxford of the future will doubtless furnish at least some of them with science and scientific ideas. But in the meantime there exists throughout the universities of the country a body of some hundreds of able men of science in the form of professors and lecturers to which recourse might, one would suppose, be had when occasion arises.

The report discusses at some length the momentous question as to the employment of women in the Civil Service. All the world has now profited by the experience derived from the war, and much prejudice on this subject has been cleared away. But while many women have distinguished themselves by patriotic fervour, physical energy, and administrative ability, the education of women has in general been more defective than that of men, and it will be necessary to wait for another generation before the question can be determined on satisfactory grounds whether sex will not always stand in the way of substituting women for men in many of the professions and callings necessary to the world.

Since the issue of the report—viz. on February 12, 1919—a lecture has been given to the Royal Society of Arts by Sir Frank Heath, Chief Secretary of the Department of Scientific and Industrial Research, on the work of that Department. The lecture is lucid and interesting, and shows that some definite results have already been attained. Lord Crewe, who was in the chair, remarked that this was "the only country in which a Government Department of Research existed." Such a statement can be accepted only with some reservations. Research stations in connection with agriculture have been instituted and supported by the State in many European countries during the last half century, and the United States Department of Agriculture at Washington maintains a scientific staff and issues a very valuable illustrated annual report. Moreover, the assistance given to the universities from national funds has always been in European countries far more liberal than has ever been the case in the United Kingdom, even at the present day, when the Government grants have been so considerably augmented.

THE FAUNA OF THE INLÉ LAKE.[1]

THE Inlé Lake, lying at a height of 3000 ft. in the great limestone zone of the Shan plateau, is of peculiar bionomical interest, since, although it belongs to the Salween river-basin, it has become sequestered, or at least obstructed in its biological commerce, by the behaviour both of its principal feeders and of its only effluent, which in considerable parts of their course flow deep underground. Another point of interest in a biological view is that it appears to be a relic of a former lake, or system of lakes, of great depth and extent. Two other remarkable features of the Inlé Lake are the extraordinary limpidity of its waters, through which its animal population can be watched as in an aquarium, and its girdle of floating marshland. This curious terraqueous fringe is capable of exuberant cultivation: the local genius cuts from it an island plot, tows it off where he lists, there turns it upside down and anchors it with stakes, then dredges and adds more clotted vegetable ooze to its surface, until it becomes solid enough for tillage, and perhaps firm enough to carry a sty for his pig, or a hut for himself. Such an islander, as he turns from spearing and trapping fish to tend with incessant care the homely market-garden trade, or strictly meditate the vocal pig, might well avouch the philosophy of Thales.

In this fine report, which includes twenty-eight first-class plates, and more than 200 large pages close packed with information both descriptive and ratiocinative, the fauna of the lake (exclusive of the plankton) is fully disclosed. Dr. Annandale, the editor, contributes an introduction mainly physiographical, a summary comprehensively biological, compendious treatises on the fishes and the aquatic mollusca, and minor papers on the sponges, hydrozoa, polyzoa, and amphibia. Among other contributions may be mentioned that by Mr. S. W. Kemp on the Decapod Crustacea, that by Mr. C. A. Paiva on the Aquatic Hymenoptera, and those by Mr. Baini Prashad on the Marsupium and Glochidium of

[1] Records of the Indian Museum, vol. xiv. (Calcutta, 1918).

Physunio, and on the anatomy of a Chironomid larva of the genus Polypedilum.

The most peculiar elements of the fauna are the fishes and mollusca. Of fishes there have been found thirty-one species, representing seventeen genera and seven families; among the many new forms is an extraordinary eel-like creature which Dr. Annandale regards as a type of a distinct family of Apodes. Common features of the fishes are a large eye and small development of tactile appendages—features thought perhaps to be directly correlated with the remarkable transparency of the water. Of aquatic mollusca thirty-seven species are mentioned—a large proportion being new—representing twelve genera and eight families; they are said to display extraordinary variability, and their evolutional plasticity is discussed with much learning and an equal wealth of illustration.

Altogether, this investigation of the fauna of the Inlé Lake is a refined piece of work, reflecting high credit on the new zoological survey of India and its versatile director. Moreover, although the report shows an intelligent appreciation of the economic perspective, as is seen in the full and critical description of the fisheries of the lake and all their apparatus, it is free from any taint of that meretricious stuff which so commonly in ponderous administrative circles of the British Empire lives and spreads aloft under the pseudonym of science.

NOTES.

THE first number of NATURE appeared on November 4, 1869, so that the jubilee of the journal will be attained next week. In celebration of this event the issue of November 6 will be devoted to articles upon scientific progress and developments of the past fifty years, contributed by eminent workers in different fields. Through the active co-operation of these authorities it has been possible to secure a comprehensive collection of articles of great interest, which we believe will be accepted as a worthy epitome of outstanding advances in the half-century during which NATURE has been published.

A MEETING of the International Electrotechnical Commission was held in London on October 20 and the three following days, under the presidency of M. Maurice Leblanc. Representatives of twenty nations were present, and the reports of the various committees were considered. Signor Semenza stated that national agreement had been obtained in Italy on the subject of symbols, both in those used in textbooks and in those used in engineering drawings. He pointed out the many advantages that would ensue if international agreement could be obtained. The British list of symbols, which is finished and will shortly be published, is very similar to the Italian list, and complete agreement could be easily obtained. Nearly all the committees on nomenclature have published lists of definitions, etc., and the next step to take is to compare them all closely and then to issue a standard list. The committee on the rating of electrical machinery has been very busy, and has held many meetings. This subject, however, proves to be very difficult, as trade considerations have to be taken into account. The commission has definitely taken up the question of preparing a specification for aluminium on the same lines that it adopted for specifying pure copper. The copper specification was most useful, and has been adopted by every country in the world. A special committee was appointed to consider the question of screw-lamp caps and holders. This country is almost the only one which retains bayonet-holders for electric lamps, although many electrical engineers think that the screw-lamp caps are the best. Sir Richard Glazebrook presided at the banquet, and the Right Hon. A. J. Balfour made a thoughtful speech on standardisation which was much appreciated by all the engineers present. He pointed out that if it did not entirely prevent waste, it at least diminished it.

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 27, the following office-bearers and members of council were elected:—*President:* Prof. F. O. Bower. *Vice-Presidents:* Prof. G. A. Gibson, Dr. R. Kidston, Prof. D. Noël Paton, Prof. A. Robinson, Sir George A. Berry, and Prof. W. Peddie. *General Secretary:* Dr. C. G. Knott. *Secretaries to Ordinary Meetings:* Prof. E. T. Whittaker and Dr. J. H. Ashworth. *Treasurer:* Dr. J. Currie. *Curator of Library and Museum:* Dr. A. Crichton Mitchell. *Councillors:* Prof. P. T. Herring, Prof. T. J. Jehu, Dr. A. Lauder, the Hon. Lord Guthrie, Prof. R. A. Sampson, Prof. J. Lorrain Smith, Dr. W. A. Tait, Surg.-Gen. W. B. Bannerman, Mr. H. M. Cadell, Prof. A. R. Cushny, Sir J. A. Ewing, and Mr. G. J. Lidstone.

MR. BRUCE FREDERIC CUMMINGS, who died on October 22, will probably be known to a wider public as "W. N. P. Barbellion," author of "The Journal of a Disappointed Man," noticed by us on July 10 last, but his few scientific papers will ensure for him a no less enduring, if a more limited, reputation. Born at Barnstaple in August, 1889, in spite of meagre circumstances and increasing ill-health he taught himself zoology to such good purpose as to gain an assistantship in the entomological department of the British Museum, which he entered in January, 1912. He had previously contributed notes on local natural history to the *Zoologist*, and had been offered in the Marine Biological Laboratory at Plymouth a post which the illness of his father prevented him from taking up. In his "Journal" he affected scorn for the entomological work to which he was set, but his studies of lice soon gave rise to important papers published by the Zoological Society and in the *Annals of Natural History*. Another paper of much interest was on a scent-organ in the caddis-fly, *Sericostoma personatum*. Failing health caused him to resign his appointment in July, 1917. Mr. Cummings might never "have revolutionised systematic zoology," but he gave something more than the promise of distinguished work.

IN a Memorandum by the Chancellor of the Exchequer on the future Exchequer balance-sheet (Cd. 376) an attempt is made to arrive at very tentative revised estimates of the national revenue and expenditure in a "normal" year. The estimated normal yearly expenditure is 808,000,000*l.*, and includes the following items:—Education, 45,900,000*l.*; upkeep of museums and galleries, 600,000*l.*; and scientific investigation and research, 400,000*l.* The year 1919–20 will not be a normal year, but as regards the above items of expenditure the only difference in the estimate is that the education is down for 41,000,000*l.* instead of 45,900,000*l.*

DR. K. E. LAMAN, leader of the Congo mission of the Swedish Missionary Union, has lately returned to Stockholm with a large collection of ethnographical material drawn from the Bakongo, Bateke, and Bakuta people, as well as from five races of Ngunu.

This will be distributed between the ethnographic department of the Swedish Riksmuseum, the Ethnographic Museum of Gothenburg, and the Missionary Union's museum. Dr. Laman has made six visits to the Congo since 1890, and has paid particular attention to the language. His collection includes gramophone records of native songs.

THE Swedish Academy of Science has reported favourably on a request by Prof. J. G. Andersson (formerly Director of the Swedish Geological Survey) for a Government grant of 90,000 kronor towards scientific researches and collections in China, where Dr. Andersson is now Geological Adviser to the Chinese Government. It is hoped that the Swedish Riksmuseum will thus receive rich collections in palæontology, prehistory, and zoology, but, to comply with conditions laid down by Profs. Andersson and Wiman, the fossil vertebrates will go to Upsala.

ON October 21 the Manchester Chemical Club (president, Mr. R. H. Clayton) was incorporated with the Manchester Literary and Philosophical Society. A new chemical section of the society has been formed, and Sir William J. Pope, professor of chemistry in the University of Cambridge, delivered an address on "The Photography of Coloured Objects" to a large audience at the opening meeting on October 24.

A COURSE of twelve Swiney lectures on "Geology and Mineral Resources of the British Possessions in Africa" will be given in the lecture-theatre of the Imperial College of Science and Technology (Royal College of Science, Old Building), Exhibition Road, S.W.7, by Dr. J. D. Falconer, on Mondays, Wednesdays, and Fridays, at 5.30, beginning on Monday, November 10. There will be no charge for admission.

A JOINT meeting of the Royal Society and the Royal Astronomical Society will be held at the Royal Society on Thursday, November 6, at 4.30 p.m., for the discussion of observations made during the total solar eclipse of May 29 last. Sir Frank Dyson will open the discussion, and will be followed by Prof. Eddington and other members of the eclipse expedition.

THE Aristotelian Society will open its forty-first session on November 3. The president, Prof. James Ward, will deliver the inaugural address on the subject "In the Beginning . . ." The congress which the society arranges annually will be held next year at Oxford in September, and the French Philosophical Society will take part.

THE opening meeting of the new session of the Institution of Electrical Engineers will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Thursday, November 13, at 6 p.m., when the president, Mr. Roger T. Smith, will deliver his inaugural address.

THE one hundred and first session of the Institution of Civil Engineers will be opened on Tuesday, November 4, at 5.30 p.m., when Sir John Purser Griffith, president, will deliver an address, and will present awards made by the council for papers dealt with during the past session.

SIR HENRY ALEXANDER MIERS, Vice-Chancellor of the University of Manchester, has been appointed by an Order of Council dated October 16 to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

THE first meeting of the session of the Royal Geographical Society will be held at 8.30 p.m. on Monday, November 3, at the Æolian Hall, New Bond Street, when Major Kenneth Mason will read a paper on Central Kurdistan.

MESSRS. HODGSON AND CO., 115 Chancery Lane, W.C.2, are to sell by auction on Thursday, November 13, and Friday, November 14, the library of the late Sir William Crookes. A catalogue is obtainable from the auctioneers upon application.

AN interesting series of fragments of prehistoric pottery was found early in the year in Eastern Macedonia near Drama and the plain of Philippi. The chief importance of the discovery lies in the relation with both the north and the south which is seen in the types of pottery found. Pottery similar to the so-called Dimini ware of Thessaly, and not hitherto found in Macedonia, occurred in large quantities. Fragments of a white-on-black ware of a date later than the Dimini ware and common in Thessaly were also found. A few fragments of this latter ware were found in Macedonia in 1916 near Salonica. Some remarkable fragments showed a combination of the white-on-black painted technique with incised white-filled patterns, thus showing that the two types of technique were contemporaneous. The wares of a northern type consisted for the most part of simple pottery decorated with large spiral or semi-spiral designs. Similar wares are common in the Upper Maritsa Valley near Philippopolis and generally in the Danubian area, and are essentially northern in type. A number of clay figurines of men, women, and domestic animals were also found. The human figures are for the most part steatopygous. The importance of these discoveries for the prehistoric study of Macedonia cannot be overestimated. The series will be published in the forthcoming Annual of the British School at Athens.

THE October issue of *British Birds* contains an extremely interesting account of the nesting habits of the sparrowhawk. The author, Mr. J. H. Owen, gives a vivid description of the bathing habits of this bird and of its playful feints at capturing prey. At one time a hen he had under observation stooped at a rabbit two or three times, yet made no serious attempt to seize it; at another it trifled in the same way with a brood of partridges. But perhaps the most important of Mr. Owen's notes are those concerning the efforts of the bird to protect her eggs from the sun, which she did at the cost of great distress to herself. The nestlings suffered no less from this cause; at times, indeed, they were on the verge of collapse. Some very beautiful illustrations add greatly to the value of these notes.

THE first number of the *Radio Review*, a monthly magazine devoted to scientific radio-telegraphy and radio-telephony, has been published. It contains short instalments of papers by André Blondel and Dr. Eccles on the functions applicable to directive aerials and on the internal action of a triode valve. In Blondel's paper the definitions are not very explicit, and so it is not easy to follow his reasoning. Dr. Eccles's paper is simpler, but in order to follow it the reader must have a knowledge of Child's and Langmuir's papers in the *Physical Review*. In a brief introduction the editor, Prof. Howe, states the policy and aims of the review. The remaining part of this issue consists of abstracts and reviews of books. Apparently the aim of the journal is to do for radio-telegraphy what the *Philosophical Magazine* does for physics. The amount of matter in the first number strikes us as rather meagre.

THE Institution of Electrical Engineers has issued an amended edition of its Wiring Rules. These rules

have been universally adopted in this country, and they are annually amended so as to keep them abreast of the latest practice. The amendments this year are almost of revolutionary importance. As we foreshadowed some months ago, the electricians have now abandoned measuring the size of wires in terms of the standard wire gauge (S.W.G.). They have dropped gauges altogether. Instead of speaking of a No. 20 wire, they speak of a 0·036 wire—that is, one having a diameter of 0·036 of an inch. Similarly, instead of writing 3/20 for a cable consisting of three strands of No. 20 wire, they write 3/0·036". Formerly they had a choice of fifty-seven cables for use in electric wiring, but now there are only twenty-four sizes. Careful consideration has shown that this number is sufficient. Naturally this will be a great boon to the cable manufacturers. The British Engineering Standards Association (the B.E.S.A.) is to be congratulated on having initiated this important reform.

FOR more than forty years the Institution of Civil Engineers has printed in its Proceedings short abstracts of papers on engineering subjects which have appeared in periodicals and in the Transactions of scientific and technical societies. The institution now proposes to issue them separately in quarterly numbers, the first of which appears this month. Although its length is affected by the difficulty of obtaining periodicals from abroad, the first number gives ninety-nine abstracts, which cover seventy pages. Subject- and name-indexes are provided, and it is much to be desired that these should be made more useful by co-ordination in annual or two-yearly indexes. The abstracts are grouped under two heads:—Materials, Measurements, etc., and Engineering Practice. As the latter term is interpreted generously, there is some overlapping with abstracts issued by other bodies, and some system of interchange of abstracts will have to be evolved to prevent several abstracts of the same paper being written.

AT University College, London, on October 21, a public lecture was given by Prof. J. A. Fleming entitled "Speaking Across the Atlantic by Wireless Telephony." Prof. Fleming opened by giving a general review of the physical facts leading up to ordinary telephony, and the application of Fourier's theorem to wave-forms, with their consequent resolution into harmonics, and the distortion produced in ordinary speech, due to the different velocities and damping of the various harmonics. Since the electromagnetic waves employed in wireless telegraphy have a velocity which is independent of the wave-length, and a falling-off of intensity with distance which is the same for all frequencies, there is no distortion of the sound in wireless telephony similar to that which occurs in long-distance telephony of the ordinary kind. Speech transmitted by wireless is particularly clear and distinct. The three typical modes of producing electromagnetic waves were explained and illustrated by lantern-slides—the high-frequency alternator, the Poulsen arc, and the three-electrode thermionic valve used as generator. Prof. Fleming explained the mode of action of the Fleming valve as a rectifier, and the development of the three-electrode valve from this. The Marconi Co. now uses seven such valves in cascade for amplifying in receiving the feeble trans-Atlantic speech, since the amplification increases geometrically with the number of valves used. By a series of trials the Marconi Co. has demonstrated the possibility of speech over 1800 miles across the Atlantic, and, moreover, the trials were carried out at an unfavourable time of day, 10 a.m. to 1 p.m. The audience was large and appreciative, one of the larger lecture-theatres of the college being required. A course of six lectures on "Thermionic Valves" is to follow on succeeding Wednesdays at 5 p.m.

Messrs. Chapman and Hall, Ltd., announce:—"Aeronautical Engines," Major A. G. Clark; "Theory and Practice of Aeroplane Design," S. T. G. Andrews and S. F. Benson; "Geometry for Architects and Builders," J. E. Paynter; "Mathematics for Engineers," W. N. Rose, vol. ii.; and "Metric System for Engineers," C. B. Clapham. *Mr. W. Heinemann* is to publish this autumn Sir Ernest Shackleton's new book. It will be entitled "South: The Story of Shackleton's Last Expedition, 1914–1917." *Messrs. G. Routledge and Sons, Ltd.*, promise "Bakery Machinery," A. W. Mathys; "The Utilisation of Natural Powers," E. L. Burne; "Engineering Instruments and Meters," E. A. Griffiths; "Direct-current Dynamos and Motors," Prof. W. B. Griffith; and "Manufacture and Installation of Electric Cables," C. J. Beaver (in the Industrial Supremacy Books Series). In their Efficiency Books they will publish "Bibliography of Industrial Efficiency and Factory Management," H. G. T. Cannons, and a new edition of "Lectures on Industrial Psychology," B. Muscio. *Messrs. H. Sotheran and Co.* will shortly issue an Illustrated Library edition of their "Bibliotheca Chemico-Mathematica." It will contain many full-page plates, reproductions of title-pages, textual passages from rare or historically important works, and an analytical subject-index.

THE special catalogues of Messrs. H. Sotheran and Co. (140 Strand, W.C.2) are models of what catalogues of second-hand books should be, for they furnish in an interesting manner much out-of-the-way information respecting many of the volumes offered for sale, and are carefully classified. Messrs. Sotheran's latest catalogue (No. 773, 2*s.* 6*d.* net) deals with rare books on exact and applied science, and includes the library of the late Prof. Henrici and a portion of that of Prof. G. Govi, of the University of Naples. Its 3336 items are classified under the headings: General and Collected Works; Mathematics; Astronomy and Geodesy; Dialling and Horology; Physics; The Microscope and Microscopy; Meteorology and Physical Geography; Chemistry; Crystallography; Chemical Technology, including Photography; Mining and Metallurgy; Engineering; Seamanship, Airmanship, and Naval Architecture; and sets of Learned Societies' Publications and other scientific journals. The catalogue will be very useful for reference.

OUR ASTRONOMICAL COLUMN.

LARGE METEORS.—On October 21, at 8h. 35m. G.M.T., a meteor brighter than Jupiter was observed by Mrs. Wilson at Totteridge, by Mr. C. P. Adamson at Wimborne, and by Mr. H. G. Baker at Wangford. It was directed from a radiant near α Cephei, and moved slowly at an average height in the atmosphere. On October 22 at 7h. 42m. G.M.T. a bright meteor was seen from Bristol, Stowmarket, Wimborne, and Plumstead, S.E. It had a very long horizontal flight of about three hundred and thirty-five miles at a velocity of thirty-three miles per second, and passed from over a point twenty miles north-east of York to thirty miles south-west of St. Valery, France. Its height was about seventy-four miles, and its radiant at 156°+39°. It is very suggestive that the radiant point of meteors from the comet of 1739, as computed by Prof. A. S. Herschel, was at 157°+39° for October 22; meteor speed = 39 miles per second. The

comet passed about 7,500,000 miles outside the earth's orbit.

COMET 1919*b* (BRORSEN-METCALF).—Messrs. Braae and Fischer-Petersen have redetermined the orbit of this comet from observations on August 21 and September 7 and 27. They first assumed the period as seventy-two years, and found that on this assumption there were residuals of $+1{\cdot}61'$, $-1{\cdot}47'$ in longitude (great circle) and latitude in the middle observation. They then left the period to be determined by the observations, and obtained the following orbit (*Ast. Nach.*, No. 5015):—

T = 1919 Oct. 17·156 G.M.T.	log q = 9·68695
ω = 129° 53·10′	log e = 9·98229
Ω = 310° 28 56′ 1919·0	Period = 42·465 years
i = 18° 53·02′	

The residuals are now $-0{\cdot}21'$, $-0{\cdot}12'$, and, as it appears that a further reduction of the period would make them smaller, it is concluded that the comet has made two revolutions since 1847. The observations in that year were not very numerous, and the periods then deduced were liable to much uncertainty.

If the 36-year period is right, the comet belongs to the family of Uranus, not to that of Neptune as formerly supposed.

It is now more than ever desirable that the comet should be observed for as long a period as possible. The following ephemeris, for Greenwich midnight, has been corrected approximately for the change in the orbit:—

	R.A.	S. Decl.	Log r	Log Δ
	h. m. s.	° ′		
Nov. 2 ...	12 33 8	4 39	9·7962	0·0932
6 ...	12 43 31	7 23		
10 ...	12 53 44	9 59	9·8750	0·1424
14 ...	13 3 36	12 18		
18 ...	13 13 8	14 25	9·9464	0·1808
22 ...	13 22 20	16 22		
26 ...	13 31 8	18 10	0·0090	0·2111

THE NEW LABORATORIES AT ROTHAMSTED.

ON Monday, October 20, the new laboratories at Rothamsted were opened by Sir Arthur Griffith-Boscawen, Parliamentary Secretary of the Board of Agriculture and Fisheries, in the unavoidable absence of the Right Hon. Lord Lee of Fareham, President of the Board of Agriculture, who had intended to be present himself. There was a distinguished gathering of men and women interested in the practice of agriculture and in the sciences underlying it, which included Sir Horace Plunkett, the Hon. Rupert and Lady Gwendolen Guinness, Sir David Prain, Sir Francis Watts, Mr. Otto Beit, Prof. V. H. Blackman, Dr. M. O. Forster, Prof. MacBride, Sir Robert and Lady Robertson, Mr. Arthur Sutton, Mr. M. R. Pryor, Dr. M. C. Rayner, Dr. T. A. Henry, Dr. J. A. Voelcker, and others.

The chair was taken by Prof. H. E. Armstrong,

vice-chairman of the Lawes Agricultural Committee, who said that Rothamsted had long been known throughout the world as the chief centre of scientific inquiry into the problems of agricultural practice. It was now the Mecca of agricultural pilgrims. Its sphere had been further widened by the recent action of the Board of Agriculture in establishing there an institute for the study of plant pathology, where entomological and mycological investigations could be carried on. The demands of modern scientific workers were very considerable, but no pains had been spared to make the equipment and laboratories as efficient as possible. The total cost of these improvements had been 26,000*l.*; of this sum no less than 10,000*l.* was collected in public subscriptions from farmers and their friends. The Board of Agriculture gave generous assistance, and granted an equal sum—10,000*l.*—from its Development Fund. The remaining 6000*l.* had been given by private donors and obtained in other ways. Fortunately, the

work was completed before the recent rise in prices, and at a conservative estimate could not be done now for less than 60,000*l*.

Sir Arthur Griffith-Boscawen said that for many years agriculture had been neglected by the State, but its national importance was discovered during the war, and he knew it was the intention of the Government, and of the Prime Minister in particular, that agriculture should not be neglected in the future as it had been in the past. It was possible that some of the methods proposed might lead to controversy, but he was sure that on one point there would be complete agreement, and that was the necessity of adequate provision for research in agricultural science. It was a fortunate, and perhaps significant, coincidence that the opening of the new Rothamsted laboratories was almost simultaneous with the Prime Minister's speech, which might announce an important agricultural policy. Sir Arthur expressed his faith in the system of demonstration farms, at which farmers could see new methods in operation. But behind and above all such farms must be the research stations, where facts and principles could be ascertained in a truly scientific manner and with truly scientific precision. The Board of Agriculture realised that reduced expenditure on agricultural research would be false economy; it was essential that agricultural production should be increased and that the best possible advice should be available for the farmer. The Board of Agriculture was conscious of the splendid work that was being done at Rothamsted, and he wished every success to that admirable institution.

The Hon. Rupert Guinness, in thanking Sir Arthur Griffith-Boscawen for having, at only an hour's notice, taken Lord Lee's place, emphasised the need for increased facilities for investigations in agricultural science as one of the surest means of progress, and expressed his satisfaction with the work done at Rothamsted.

Sir Horace Plunkett, in seconding the vote of thanks, referred to the simplicity of language in which the results of the Rothamsted inquiries were expressed, thereby making them intelligible to the ordinary farmer.

The door of the building was then opened by Sir Arthur Griffith-Boscawen, and the company proceeded to the inspection of the various laboratories and of the interesting series of exhibits which had been arranged by the staff.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. J. E. PETAVEL, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

DURING the last five years every resource of the Empire, moral, intellectual, and material, has been concentrated on one great task, now successfully achieved; and the present period marks the end of a gigantic military struggle and the beginning of a new social era

I.—*Engineering and Science during the War.*

To summarise adequately the part played by engineering in the war would constitute a task far beyond the power of the writer or the scope of the present address. Now, as in the past, the fate of nations in war or peace is primarily determined by moral, intellectual, and physical attributes; but, under modern conditions, these forces can find efficient application only through the agency of science and engineering.

A large army depends for its subsistence and equipment on the combined effort of every branch of human activity; and every productive industry, when organised on a large scale, is in turn dependent upon the engineer.

Before the end of the war this country had become transformed into one vast factory, every department of which required the services of trained engineers. Every member of this section has contributed his own share to the task, and our programme includes papers giving detailed accounts of several branches of the work.

It is fitting, therefore, that I should restrict myself to a mere outline of some of the more outstanding facts.

The urgent necessity for an output of munitions vastly in excess of any previous production made centralisation and standardisation essential, and involved a complete revolution in workshop practice. The Ministry of Munitions was responsible for the formation of the required organisations and guided the transformation of industrial conditions, and, when the dilution of skilled labour became inevitable, the technical engineer designed the machinery and devised the methods which made efficient work possible.

Credit is due to the unions for the concessions made; greater credit to the women for their enthusiastic response to the call and the steady output they maintained.

Munitions.—The Ministry of Munitions was created in May, 1915, its early efforts being concentrated on the production of guns and shells. A year later the Ministry was in a position to meet the ever-increasing demands of the Army, and by 1918 a large reserve of munitions had been established, the expenditure being limited only by difficulties of transport at the Front. The maximum expenditure of ammunition was reached one day in October in that year, when 900,000 shells, weighing 40,000 tons, were fired. The total number of guns manufactured during the war was 20,000, and more than 200,000 machine-guns had been delivered by November, 1918.

The Ministry of Munitions took charge also of the production of aircraft, which were ultimately turned out at the rate of 4000 per month; later, the provision of motor transport was in addition placed under its control. Finally, our production of "poison gas," for which this Ministry was responsible, rose during the last few months of war to several thousand tons a month, sufficient to make the Germans rue the day on which they had introduced this weapon into warfare.

Among the inventions which have had an influence on military operations I will mention only three as typical of three distinct classes:—

Tanks were first used in 1916, and the results produced were greatly enhanced by the surprise created, and consequent moral effect, but the idea of an armoured chariot is as old as organised warfare. The problem of constructing a vehicle which could travel across the trackless and shell-pitted district which extended between the two armies remained to be solved. In the light of the experience gained with various types of tractors it was, however, clearly not insoluble, and credit is due to the man who had the courage to hazard a novel and important experiment. The resulting tank was the product of careful design and experiment, and the outcome of the co-operation of several engineers with special knowledge. Sound-ranging introduced the complex methods and delicate instruments of physical research into the trenches,

and, against all precedents, proved them to be trustworthy and practical under the most adverse conditions. The Stokes gun, on the other hand, superseded all other trench-mortars by simplicity of design of manufacture and convenience in handling; 20,000 of these guns were used during the war.

Transport.—On August 4, 1914, the Government assumed control of the railway systems in this country, but the working and management were left in the hands of the railway officials, and to them is due the smooth working of the lines during a long period of exceptional difficulty. British engineers, civil or military, have been responsible for the transport through France, and during the last two years of the war large numbers of engines were sent across the Channel and miles of track were taken up in England and relaid in France. Road transport was organised on an unprecedented scale, and 100,000 new vehicles were delivered. A network of narrow-gauge railways was carried right up to the trenches, and numerous new roads, railway lines, and bridges constructed. Railway construction formed an important factor in connection with the advances in Mesopotamia and Palestine; in the latter case the entire water-supply had for a long period to be drawn from the Egyptian base through a specially laid pipe-line.

In France and elsewhere the armies were primarily dependent upon sea transport for their food and equipment. This service, organised by the Navy, culminated in the unique effort which brought American troops at the rate of 300,000 per month, and thus overbore the balance which for four years had been oscillating between defeat and victory.

Among the notable new departures the cross-Channel train ferry and the portable steel bridges, principally of the Inglis type, should be specially mentioned.

Navy.—At the outbreak of war the Navy was ill-prepared with regard to anti-submarine defence and mining. The influence of the submarine on naval warfare had been under-estimated, and mines were regarded as a somewhat discreditable means of destruction; but during 1915 the depth-charge and the paravane were developed by the Naval Experimental Department at Portsmouth, and later thousands of these were brought into use. In principle the depth-charge consists of a canister containing a large charge of explosive and a pistol actuated by a hydrostatic valve. The merit of the invention resides in the simplicity, safety, and trustworthiness of the mechanism. In designing the paravane the body was borrowed from a torpedo, and wings, rudder, and elevator from an aeroplane. The secret of the device lies in the stabilising mechanism, which enables it to keep its position when the ship is running at high speeds. The paravane enabled most ships to pass unscathed through a minefield, and in a slightly modified form it served to seek out and destroy submarines under the water.

Sound-location proved to be one of the most valuable inventions developed by the Board of Invention and Research. By its means the position of a submarine explosion off the coast of Belgium could be found within a few hundred yards by observers on the English coast; passing ships or submarines could also be identified and located. Sound-locators were also used on board anti-submarine craft, but at the time of the armistice were for this purpose being superseded by other methods.

Mine construction, laying, and sweeping formed the object of many successive improvements. Mines of special construction, which cannot be swept by ordinary means and explode without actual contact, were used in large numbers in 1918, and were particularly effective against submarines. Various new types of oscillating mines were also developed.

Many of the newer fighting units of the Navy were designed for speeds far in excess of anything that had been previously contemplated; the attainment of the required horse-power was rendered possible by improvements in boiler construction, by the development of oil-firing, and by the invention of the geared turbine. At the present time the horse-power of some of the fastest destroyers equals that of any pre-war Dreadnoughts.

Numbers of strange craft were designed for special purposes. The monitor was used as a floating fortress, and ships without funnels or masts formed cruising aerodromes. The torpedo-net was known to be ineffective as well as inconvenient, but some years elapsed before ships were rendered immune from torpedo attacks by a wide outer sheath of resilient construction. Some protection was first given to minesweepers by fitting the vessels with a false prow; the newer minesweepers were rendered nearly unsinkable by the provision of numerous bulkheads. The submarine was developed with regard to size, range, and speed. The latest, and perhaps the strangest, craft was the submarine fitted with a heavy calibre gun which could be fired when all but the muzzle was submerged.

Aircraft.—The rapid progress and expansion of aeronautical science and construction are perhaps the most remarkable achievements of engineering during the war.

In 1909 Blériot flew the Channel. In 1910 Cody won the British Michelin Cup by a flight of 185 miles. The Royal Flying Corps was formed in 1912, and it was decided that the equipment should consist of seventy-two aeroplanes and two airships. The number of aeroplanes available in 1914 was less than 200; the number ultimately required proved to be more than 3000 a month. The aeroplanes which were sent out with the Expeditionary Force in 1914 had a maximum speed of some 80 miles an hour, a rate of climb at ground-level of 300 ft. or 400 ft. a minute; they were equipped with engines of 60 h.p. to 100 h.p. In 1918 the fast machine had a maximum speed of 140 miles an hour, a rate of climb at ground-level of 2000 ft. a minute; single-seaters were fitted with engines of 200 h.p to 300 h.p., and the largest machines were equipped with a power plant developing more than 1300 h.p. The maximum height attainable had increased from 5000 ft. to 25,000 ft.

The Atlantic flight has given the measure of the success achieved in the design of long-range bombing machines. Two types were evolved: the fast day bomber, capable of carrying a useful load of about 3000 lb. at a speed of 130 miles an hour, and the night bomber with a larger load and slower speed. The largest aeroplane manufactured in numbers was the Handley Page V/1500, with a weight of 11 tons and a power plant of 1300 h.p. Three days before the armistice two of these machines stood fully equipped waiting for the order to start for Berlin. The largest bombs in use weighed more than a ton, and during the war 8000 tons of explosives were dropped on the enemy. The experience which they had gained in the construction of the high-powered engines required for airship work proved to be a valuable asset for the Germans. Initially also their rate of production, both of aeroplanes and engines, was far superior to ours, and, faced with the menace of otherwise being for a period deprived of machines, we were bound to continue the use of a certain standardised types longer than was desirable.

The labour difficulty was overcome by the introduction of a large proportion of female labour, which proved to be very suitable for aeroplane manufacture,

and especially for wing construction. The bulk production of aero-engines presented grave difficulties. Every part had to be made to close limits so as to be interchangeable, and it was necessary to maintain the highest quality with the minimum amount of skilled labour. For a period the supply of magnetos was both inadequate and unsatisfactory. The Germans had acquired practically a monopoly in this direction, and it became essential for us to build up a new industry on the results of careful research and experiment. The fact that in these circumstances a total of 8,000,000 h.p. was produced during the last twelve months of the war represents one of the greatest achievements of engineering organisation.

Synchronised gun-firing through the propeller was first brought into use by the enemy, and the success of the Fokker was due, not to superior design, but to this characteristic armament and to the relatively high engine power. On the other hand, throughout the war the only stable machines were British. For observation work, night flying, and flight in fog and cloud the advantages of a stable machine are obvious. Instability, inasmuch as it favours rapid and unexpected manœuvres, was for a time regarded as an advantage in aerial fighting, but later experience proved that a well-designed aeroplane could be made stable and yet remain quick and light on the controls.

Seaworthiness, no less than airworthiness, is required of the seaplane, and this implies a machine of considerable size and weight. Most of the best seaplanes in use in 1918 had a total weight of four or five tons each, a speed of nearly 100 miles, and engines of about 700 h.p.

The machines used by the special aeroplane-ships were principally small fast scouts, but one type was of sufficient size to carry an 18-in. torpedo. In 1918 seventy aeroplanes were carried by the Fleet as part of the regular equipment.

Airships proved to be of great importance in connection with naval work. The smaller non-rigids were used for patrol duty along the coast and convoy service, and by their means a submarine could be detected and attacked while still at a considerable distance below the surface. The success achieved was extensive, and ships convoyed by airships were practically immune from submarine attack. The larger non-rigids served as scouts in naval operations.

The SSZ had a speed of 50 miles and a gross lift of about two tons; the North Sea type a lift of 11 tons and a speed of 60 miles.

Compared with the achievements in other directions the record of British work in connection with the development of rigid airships is not entirely satisfactory. In this field, where consistent policy and firmness of purpose were essential, the Admiralty vacillated strangely. The *May-fly*, constructed at Barrow in 1910, was admittedly an experiment, and although an accident ended her career after the first few mooring tests, she had already served her purpose in providing the experience and data necessary for a more perfect construction. Nothing further was done, however, until after the war had started.

In Germany, on the other hand, painstaking plodding had built up success on the ruins of a dozen failures.

Improvements in the rate of climb of aeroplanes and the invention of the incendiary bullet brought an end to the effectiveness of the Zeppelin as a bomber, but as a scout in long-range naval operations its influence remained considerable, and the recent successful journey of R 34 indicates the possibilities of the rigid airship in times of peace. The useful load increases rapidly with size, and a ship 15 per cent. larger than R 34 in linear dimensions could have carried 100 people to America.

What is popularly known as an invention, or an idea of revolutionary importance emanating from one person, has played relatively little part in the recent development of aeronautics. Success has been due to systematic investigation and the combined effort of many scientific workers, trained designers, and practical constructors. With some exceptions the same holds true in the case of engine construction. Inventions there have been (8000 are duly recorded in the files of the Air Inventions Committee), but equipment and armament and accessories appear to have offered most scope for brilliant new departures.

Several inventions notably influenced the course of the war. The successful manufacture of incendiary bullets put an end to the Zeppelin raids, tracer bullets increased the accuracy of aim, and synchronising gear made it possible to fire through the propeller at the rate of nearly 1000 rounds per minute. A satisfactory self-sealing petrol tank was manufactured after many unsuccessful attempts, and greatly diminished the risk of fire. Much ingenuity was displayed in connection with bomb-sighting and navigational instruments. Wireless telephone and directional wireless were introduced. A trustworthy turn-indicator and improved compass made accurate navigation through clouds possible. Armoured aeroplanes were constructed; special machines were also designed for carrying 37-mm. quick-firing guns for use at the Front and against submarines; these guns fired a 1½-lb. high-explosive shell.

The increased efficiency of the anti-aircraft artillery and the high rate of climb of the defending machines put a check on daylight aeroplane raids, while at night and in mist both searchlights and guns could be trained on the enemy, even if invisible, by means of sound-directors. A screen of kite-balloons supporting nets formed part of the night defences of London, and justified its existence by the moral effect produced on the enemy pilots.

The use of airships near the fighting zone or within reach of enemy aeroplanes was impossible owing to the inflammable nature of the gas they contained, and, in spite of all precautions, the loss in kite-balloons was serious. The proposal to replace the hydrogen by helium came from a member of the Board of Invention and Research, and in 1915 experiments were started with a view to the ultimate production of several million cubic feet per month. The boldness of the idea is best emphasised by the fact that at that time it took weeks to obtain the few cubic inches of gas required for the preliminary permeability tests. Progress was accelerated when America came into the war, and at the time of the armistice a supply of 350,000 cubic ft. per week was ensured.

The above outline of engineering activities during the war is both incomplete and imperfect. It may, however, serve to emphasise and illustrate the two features which characterised the period and made victory possible.

The first is: Large production, obtained by organisation, standardisation, and co-operation.

The second is: Rapid progress resulting from the stimulus to research and invention and the immediate application of the results obtained.

The required organisation did not arise as a natural development of the pre-war industrial activity; it was called into being by dire necessity and applied with grim determination. Before the war the British nation was anti-militarist, non-scientific, and strongly individualistic. To achieve victory the nation accepted universal conscription, and submitted to the

mixture of Socialism and tyranny which necessity dictated. Under extreme pressure scientific knowledge, technical skill, industrial ability, military and naval experience welded into a homogeneous and efficient organisation.

It is easy to disparage the effort or to point to defects, large or small, which tarnish the record, but the fact remains that, whereas in 1914 we were inferior to the enemy in every military asset except moral courage, in 1918 victory came as the result of mastery in practically all the thousand factors on which modern warfare depends.

The organisation involved the direct control of food, every essential raw material, shipping, and transport; further, under the cloak of various euphemisms, it involved the indirect control of all available capital and labour. The capitalist was granted the privilege of receiving and paying the interest on the money required. High wages and the Military Conscription Act ensured an adequate supply of labour in the factories. And these things came to pass, not by the tyrannical order of an all-powerful Government, but by the force of a great idea working within the nation.

II.—*Industrial and Economic Reconstruction.*

The peace declaration is the opening of a new act in the world's greatest drama, and the events of the next few years will decide the fate of many generations. The future is always the logical sequence of the past; it is the present which gives direction to the forces which are acting in virtue of the ideals which are operative. The world is emerging from a furnace, and the rigid constitution of civilisation, for a moment plastic, will harden in the mould we form. It is, therefore, the duty of each one of us to attempt to understand the transformation which is going on, and influence it in the right direction.

The principal feature of the day is the insistent craving for better and easier conditions of life; in popular language, this is quite inaccurately expressed by a demand for higher wages and less work. The two aims are far from identical; in fact, a little consideration will show that in some respects they are contradictory.

The total remuneration received by a nation is measured by its production, and this law cannot be altered or affected by legislation or revolution. On the other hand, the share received by a class or an individual is capable of adjustment within certain limits. Thus any class may increase its remuneration either by increasing the total production or by decreasing the remuneration received by the other classes. The capitalist who corners wheat, and the miner who corners coal, are examples of the latter method. No such limitations exist, however, with regard to the face-value of the wages paid; by Act of Parliament all wages might be increased arbitrarily twentyfold, but as a result the cost of living would rise to a similar ratio.

Incalculable harm has been done by ignorance and wilful misrepresentation. During a generation the working classes have been told, and have firmly believed, that they receive but a tithe of the value of their work, and that the bulk goes to swell the fortune of the capitalistic class. The actual facts so far as engineering is concerned will be found in the address of my predecessor in this chair. On an average in pre-war days the share of the capitalist was one-ninth that of the workman. The actual position with regard to coal is now known to all. For each ton raised 19*s.* 5½*d.* goes for labour, and a total of 2*s.* is paid as royalties, owners' profits, and owners' compensation. It is obvious that the 13*s.* rise in the miner's wages cannot be paid out of profits and royalties amounting to a total of 2*s.*, but the miner, who has been brought up to believe in the fabulous profits of the wicked duke, is quite ready to strike against the owners, the Government, and the laws of arithmetic.

These facts, though clearly established, are not easily credited by the working man; he may have received a penny for what he considers is the manufacture of an article, and sees it selling for a shilling in a shop. He forgets that the price must include, not only his wage, but that of the men in the mine, the smelting works, and the rolling mill, who provided the material in the shape required, the wages of the men who built the factory in which he works and made the machine he uses, the wages of transport workers, packers, shop assistants, advertising agents, printer, papermakers, etc., and that, finally, some minute fraction of a farthing might with justice be allotted to the engineer who designed the machine or invented the process. The general position, though similar, cannot, unfortunately, be followed so closely; the limitations, however, are clear. The income of the United Kingdom per head of the population was before the war about 50*l.* If, therefore, the State were run on completely communistic lines, and if under these conditions there were no reduction either in the working hours or the output, our wages would average a sovereign a week each, and we could buy our goods at pre-war prices.[1]

The above considerations indicate that a real improvement in material welfare is necessarily associated with increased production. The needs of mankind are many, its desires are unlimited, and for this reason general over-production need never arise. Many circumstances may, however, lead to uneven balance, and, unfortunately, when this occurs, the producers of the commodity which is in excess are penalised, and those responsible for a deficiency are rewarded. The instability is fostered and increased by speculation, and, although it forms the most powerful check on national prosperity, no serious effort has yet been made to apply a remedy.

I am inclined to think that two of the most important problems of our time relate to economic balance and increased production. The solution in the former case is dependent on the statesman, the economist, and the business man, in the latter on the combined efforts of various branches of applied science, and more especially on engineering.

At one time production was directly dependent on muscular effort; it is now mainly influenced by equipment, organisation, and skill. Increased production does not necessarily imply harder work or longer hours; it can be secured by improvements in method and machinery, but only with the willing co-operation of all concerned.

Before the war the Americans were far ahead of us in stardardisation and specialised machinery. The American clock and the Ford car are two well-known examples. During the war we adopted and developed these methods. As a result, although the cost of all materials increased considerably, although the wages more than doubled and the profits were more than adequate, the cost was in many cases reduced. Thus the eighteen-pounder shell fell from 22*s.* to 12*s.*, the Lewis gun from 165*l.* to 62*l.* The importance of standardisation has been fully realised by the manufacturers of this country, and as a result we may hope to see a general reduction in cost.

The economic value of an individual depends exclusively on the nature, quality, and quantity of

[1] This statement is optimistic in so far as it does not take account of war losses.

his output, and his remuneration should correspond with his economic value. The rule is simple, its application would solve most of the problems which vex the present generation, but no scheme has yet been evolved to make its application possible.

There can be no doubt that in this respect our present system is a complete failure. It has been built up casually in the course of the industrial warfare of the last twenty years, and each side, regardless of consequences, has entrenched itself in any position won. The result is a system nearly perfect from the point of view of offence and defence, well arranged for mutual destruction, but, like the trenches in France, unsuitable for use in time of peace.

The minimum wage is beneficial in so far as it prevents sweating, but in two other respects its consequences are most unfortunate. Under the operation of this rule the man whose value is a fraction below the minimum is unemployed and economically unemployable. Further, the minimum wage becomes the standard wage, and the better men are inadequately paid. Both causes lead to decreased production. The weaker or less skilful men drift into enforced idleness, and become a charge to the community under the heading of charity, poor-law, or some newly invented euphemism. The better men, finding extra effort uncompensated, drop to an ever-decreasing minimum. Small output is in most cases the result of inadequate incentive rather than active restriction. Promotion by seniority is an example of a similar cause, producing similar effects in other classes of the community.

Among the professional and business classes the remuneration is proportional to the skill and to the effort; a barrister, an engineer, or a merchant has neither minimum wage nor fixed maximum output, and, the vagaries of chance excepted, generally speaking gets what he is worth. At the two extremes stand riches and starvation, and the economic world can offer no stronger motive forces than the allurements of the one, the fear of the other. There is no absolute reason why the working man should not be offered the same incentives to hard work and progress, but up to the present most efforts have tended in the opposite direction. Any form of payment by result is viewed with indifference or distrust by the unions, and past experience with piece-work explains that attitude. There has been a disposition for employers to make large individual earnings an excuse for cutting rates. Errors in rate-fixing may easily arise, and in certain cases special investigation might be necessary, but the advantages of high individual production are so great to both employer and employed that in all cases of doubt the higher rate should be maintained. In this connection the method of time-study first developed by Taylor in America and the various systems of payment by results which have been successfully applied deserve careful consideration.

Another important but difficult subject is the distinction drawn between skilled and unskilled labour. The experience gained during the war has proved that many operations scheduled as skilled work could be effectively performed by women who had received only a few weeks' special instruction. The oft-repeated demand for equal opportunity for all becomes a senseless parrot cry if it does not imply that an individual has the right to undertake better-remunerated work if qualified to do so. It is a misconception which leads the skilled worker to believe that such a concession would reduce his earnings. Just as it is clear that if labourers and skilled men were grouped together at a uniform wage, that wage would necessarily be lower than the present minimum for skilled work, so also the separation of tasks which require but a nominal period of training would increase the rate of remuneration available for the really skilled man.

I have directed attention to some of the difficulties which must be solved if the country is to emerge from the present crisis prosperous or even solvent. There is little doubt that an elucidation is possible, but it can only be evolved by the honest and intelligent collaboration of all parties concerned, a task rendered difficult or impossible by mutual distrust and class hatred. Class differences there are, and always will be; they exist as the result of breeding, education, and environment, but they do not extend to the fundamental characteristics of humanity. Many dukes and many miners are lazy; most capitalists and most trade unionists are greedy; all men, with a few exceptions, are selfish. The war has shown that lazy, greedy, and selfish men will die, or even work, for their country in a great exigency, but there is a limit to, and a reaction after, any profound emotional stimulus, and the present unrest and dissatisfaction are but normal symptoms. A satisfactory economic system can be based only on natural human impulses, and of these the most fundamental is self-preservation, or, more generally, self-interest. Increased production is at the present moment the most pressing national need, but it will become effective only when for every man increased production becomes the talisman by which *his* paper-wages can be turned to gold.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—A massive bronze medal has been received from the University of Paris in commemoration of the manifold services rendered during the war by the universities of the Allied nations and "in token of a friendship henceforth indestructible." It bears in relief on the obverse the figure of "Scientia Instrumentum Justitiæ—Libro—Ense—MCMXIV-MCMXVIII," and on the reverse the old courtyard of the Sorbonne, with the inscription "Fidelissimæ Sorori Universitas Parisiensis dicavit."

The thanks of the Senate have been accorded to the Worshipful Company of Drapers for renewing for a further period of two years their pre-war grant of 500*l.* a year to the biometric laboratory of the Department of Applied Statistics and Eugenics at University College; and to the London County Council for a grant of 6000*l.* for the erection of temporary buildings for the Department of Engineering at King's College.

The following doctorates have been conferred:—*D.Sc. in Chemistry:* Mr. E. K. Rideal, an internal student of University College, for a thesis entitled "The Synthesis and Thermocatalytic Combustion of Ammonia." *D.Sc. in Botany:* Mr. H. Wormald, an external student, for a thesis entitled "Researches into the Biology, Morphology, and Mode of Parasitism of the Species of Monilia Occurring on Fruit Trees," and other papers.

A course of advanced lectures on (*a*) "The Energy Balance of the Human Body," (*b*) "Electrical Signs of Emotive Phenomena," is being given by Prof. A. D. Waller, professor of physiology in the University, at 5 p.m. on Wednesdays, November 5, 12, 19, and 26, and December 3, in the physiological laboratory of the University, South Kensington, S.W.7. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

OXFORD.—The entry of freshmen at the beginning of the present term is probably the largest on record. Nearly all the colleges have admitted members far in excess of their usual numbers, and very great difficulty has been met with in finding accommodation for undergraduates both within the colleges and in the town outside. In some cases quarters have been provided by the erection of Army huts. The science laboratories are overcrowded with students.

Prof. Vines has resigned the chair of botany as from December 31, 1919. Candidates for the professorship are requested to send in their applications to the Registrar of the University by November 22 next. Applications for the chair of geometry, vacated by the death of Prof. Esson, should be sent in to the Registrar by the same date. Particulars of these two professorships may be seen in the *Oxford University Gazette* of October 22.

Mr. R. S. Troup, Assistant Inspector-General of Forests, India, has been elected professor of forestry.

A Treasury grant of 15,000*l.* has been received for the University under the condition of an inquiry into the financial resources of the University and colleges.

Counsel's opinion has been taken on the question of the powers of the University in the matter of the admission of women to matriculation and degrees. Counsel advise that the University has the power, proceeding by statute, to provide for this object; but they also recommend application to Parliament for an expressly enabling Act. A decree will therefore be proposed on November 4 requesting the burgesses of the University to take steps with the view of securing the requisite legislative sanction.

MAJOR G. THORP has been appointed chief instructor in electricity at the School of Military Engineering, Chatham.

MAJOR RUPERT STANLEY has been appointed principal of the Belfast Municipal Technical Institute, and director of technical instruction for Belfast, in succession to the late Mr. F. C. Forth.

MR. E. DE BARRY BARNETT has been appointed to the post of lecturer in organic chemistry, and Mr. R. H. Humphry to that of lecturer in physics, at the Sir John Cass Technical Institute, Jewry Street, Aldgate.

DR. W. M. MCDOUGALL, Wilde reader in mental philosophy in the University of Oxford, has been appointed to the chair of psychology in Harvard University, in succession to the late Dr. Hugo Münsterberg.

MR. B. MOUAT JONES, assistant professor of chemistry in the Imperial College of Science and Technology, has been elected to the chair of chemistry in the University College of Wales, Aberystwyth, in succession to Prof. Alex. Findlay.

THE council of the Institution of Naval Architects has awarded the Cammell Laird scholarship in naval architecture (150*l.* per annum for three years) to Mr. H. J. R. Biles, of the Fairfield Shipbuilding and Engineering Co., Ltd.; and the Parsons scholarship in marine engineering (150*l.* per annum for three years) to Mr. W. G. Simmonds, of Chatham Dockyard.

THE President of the Board of Education has appointed a Departmental Committee to inquire into the working of the existing arrangements (*a*) for the award by local education authorities of scholarships tenable at secondary schools or institutions of higher education other than universities or institutions for the training of teachers; (*b*) for the provision of free places in secondary schools under the Regulations of the Board of Education; and to make recommendations with the view of improving such arrangements, and thereby rendering facilities for higher education more generally accessible and advantageous to all classes of the population, regard being had (*inter alia*) to the migration of pupils from one school or area to another. The members of the Committee are:—Lt.-Comdr. E. Hilton Young, M.P. (chairman), Mr. E. K. Chambers, Mr. R. F. Cholmeley, Sir Mark Collet, Bart., Miss E. R. Conway, Miss Philippa Fawcett, Mr. F. W. Goldstone, Mr. H. J. Hallam, Mr. R. T. Jones, Mr. J. Murray, M.P., Major the Hon. W. G. A. Ormsby-Gore, M.P., Mr. C. J. Phillips, Mr. T. J. Rees, Mr. R. Richardson, M.P., Miss B. M. Sparks, and Mr. H. E. Mann (secretary). All communications should be addressed to Mr. Mann at the office of the Board of Education, Victoria and Albert Museum, South Kensington, S.W.7.

EARLY this year an account was given in these columns (January 23, p. 418) of a conference of representatives of scientific and educational associations interested in both the production and the distribution of knowledge, held to consider proposals for the publication of a monthly journal which should present in popular form the most recent results of research in all the chief subjects of knowledge. This conference appointed a committee to frame a scheme, and the report of the committee was presented and adopted at the adjourned meeting of the conference held on October 24. The meeting approved the title *Discovery* for the new journal, consent having been given to the use of this title by Sir Richard Gregory and by Messrs. Macmillan and Co., Ltd., the publishers of his book so named. Mr. John Murray will publish the journal, and Capt. A. S. Russell, recently of the R.G.A., now of the University, Sheffield, and reader-elect in chemistry at Christ Church, Oxford, will be editor. The first number will be issued on January 15, 1920, at the price of sixpence. It is understood that the journal will at first contain about twenty-four pages of matter, and will undertake in the course of the year to represent in interesting form, though it will make no attempt to describe in full, the progress of knowledge in all its chief branches. Canon Temple has been appointed by the trustees to be the first chairman of the managing committee, of which Dr. Armitage-Smith is the treasurer and Prof. R. S. Conway, of Manchester, the hon. secretary.

IT will be recalled that in July–August last a joint committee of the Empire Cotton-growing Committee of the Board of Trade and of the British Cotton Industry Research Association offered five botanical research studentships to graduates and others recommended as likely to prove successful research workers, for the prosecution of research bearing upon any of the numerous technical problems affecting the cotton industry. The studentships were of the value of 150*l.* per annum (or in certain circumstances 200*l.* per annum), and in the first instance were available for one year. Considerable freedom was allowed in the choice of the line of research, the joint committee recognising that the economic results hoped for can be obtained only by increasing the volume of purely scientific inquiry now being conducted into the physiology and genetics of plants. We are now officially informed that, although advertisement was given to the scheme and the heads of the botanical departments of the universities were approached in the matter, the response on the part of graduates has been disappointing. The committee hopes that it will be possible to offer similar studentships next year, and desires to give the scheme early publicity in order that senior students may be able to consider

the offer when planning their post-graduate work. For the present the studentships are limited to men, though with the development of the scheme it is hoped that it will cover fields open to research workers of both sexes. The studentships appear to offer considerable attractions to young economic botanists, but the joint committee will no doubt consult the heads of the botanical schools as to the probable cause of the poor response to its first offer, with the object of mitigating any drawbacks which may have become apparent in the scheme. We venture to suggest also the desirability of indicating a selection of typical problems with which the cotton industry is confronted.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 21.—Mr. William Thomson, vice-president, in the chair.—Prof. W. L. **Bragg**: Sound-ranging. A sound spreads from the point where it originates as a spherical cone moving with constant velocity. If it is intercepted by three or more stations the positions of which are accurately known, and if the time-intervals elapsing between its arrival at the stations are measured, a simple construction gives the position of the sources of the sound. Soon after the commencement of hostilities it became clear that the struggle was going to take the form of trench warfare. This gave rise to the idea of locating the enemy guns by sound in the way described. The French made experiments with sound-ranging in October, 1914, and showed that it was feasible, and the British Army was encouraged by their success to send an experimental sound-ranging section to the Front. This section started operations in October, 1915, taking up its position opposite Wytschaete. The first results obtained were poor, but they improved with experience and better apparatus. The original section became a training school for officers and men, and sufficient sections were formed to cover the whole of our Front. Each section had six microphones spaced along a base opposite the German front line. The microphones were connected to a chronographic instrument at a central headquarters, and when the sound reached each microphone it sent an electric signal recorded by the instrument. In front of the base there were two observation posts so placed that the sound reached them a few seconds before it reached the microphones, which gave time for an observer at the post to press a key which started the recording apparatus at headquarters. By studying the record the time-intervals could be measured and the position of the gun plotted on the map and telephoned to the artillery. There were between thirty and forty sections along the Front. They could locate batteries between 10,000 and 15,000 yards away with a mean error of about fifty yards. Each section sent in about one thousand results in the year.

PARIS.

Academy of Sciences, September 29.—M. Léon Guignard in the chair.—A. **Rateau**: Speech given at the James Watt centenary dinner, September 17, 1919, at Birmingham.—MM. **Blondel** and **Touly**: New arrangements of universal potentiometer amplifiers.—**Albert, Prince of Monaco**: Stray mines in the North Atlantic. In December, 1918, the author gave a chart showing the probable course of floating mines in the North Atlantic, with the view of minimising the danger to navigation. Since then thirty-three mines have been located, the positions of which are shown on an accompanying map. The conclusions of the first note are confirmed.—J. **Wolff**: Series of holomorphic functions.—M. **Foch**: The period of water-mains furnished with an air-cushion.—M. **Grard**: Thermal treatment of aluminium alloys. The alloys studied contained 3·5–4 per cent. of copper, about 0·5 per cent. of magnesium, and from 0·5–1 per cent. of manganese, and were of the duralumin type. The treatment giving the alloy the maximum malleability was found to be heating to 450° C., with a cooling velocity of 100° C. per hour. Heating to 475° C., followed by immersion in water at 20° C., gave the highest elastic limit and breaking strain.—A. **Riccò**: Heliographic latitudes of the solar protuberances (1880–1918). The observations are summarised both in tabular and graphical form, the general conclusions being more clearly shown by the latter.—C. **Benedicks**: The thermo-electricity of liquid mercury demonstrated by means of the galvanometer. In an earlier paper the author has shown that thermo-electric currents of the first species can be proved in a column of liquid mercury asymmetrically heated. These results have been called in question, and confirmation by a different method is now given.—M. **Delpech**: The flashes produced by the fire of artillery, and a general method for the extinction of these flashes. For small-bore cannon (47 mm.) a simple lubrication of the projectile with vaseline suffices to prevent the flash; for larger bores the addition of vaseline to the powder serves the same end.—P. **Thiéry**: Some new observations on the *klippes* of the Alais Plain.—Mlle. M. **Goldsmith**: The behaviour of *Convoluta roscoffensis* in presence of the rhythm of the tides.—F. **Ladreyt**: Physiological dedifferentiation and cellular reinvigoration in intestinal epithelium.

CALCUTTA.

Asiatic Society of Bengal, September 3.—**Hashmat Rai** and H. B. **Dunnicliff**: The purification of Indian sesame ("til") oil. The following conclusions were arrived at:—(1) Of all the filtering materials used, bone charcoal and French chalk are the best decolorising agents; all of them are ineffective as deodorisers. (2) Exposure to sunlight alone gives progressive improvement in colour, but the odour still persists. (3) Treatment with air alone improves the colour, but the odour is not removed. (4) Exposure to both air and sunlight combined has a very marked effect on the colour. The odour, though not absent, is not unpleasant. (5) Sulphuric acid reduces the colour very slightly, but the odour practically disappears. (6) Caustic soda acts both as a very good decolorising and a deodorising agent. (7) In all the bleached samples the colour more or less comes back on standing for a long period. (8) On heating all the deodorised samples the odour becomes perceptible. On cooling, however, it disappears.—**Hashmat Rai**: Note on nitrogen. A new method of preparation. Nitrogen gas may be readily prepared by passing an electric current through an ammonium chloride solution with platinum foil electrodes, the anode and the cathode chambers being separated by a porous diaphragm. Air is excluded from the electrolytic cell and the connecting tubes. The anodic gas is practically pure nitrogen, containing less than 0·2 per cent. of oxygen. It should, however, be collected over caustic soda solution so as to absorb any chlorine gas that may possibly be mixed with it. This affords a ready method for the preparation of a continuous supply of pure nitrogen.—N. N. **Chatterjee**: The rationalisation of algebraic equations. An earlier paper on the subject by the author was referred to in a paper by Prof. Mahendra Nath De, "The Rationalisation of Algebraic Equations" (J.A.S.B., July, 1908), in which objection was taken that the method does not always lead to an equation of the

lowest degree. The present paper aims at meeting this objection by employing the method of indeterminate coefficients, which, although applied to various other problems, has not, it is believed, been previously applied to the particular class of problems in hand.—E. G. **Barter**: Radiation pressure. This paper is a criticism of Sir Joseph Larmor's method of deducing the pressure of radiant energy, and directs attention to certain obscure points in the train of arguments used by him.

BOOKS RECEIVED.

The Genetic and the Operative Evidence Relating to Secondary Sexual Characters. By T. H. Morgan. Pp. 285. (Washington: Carnegie Institution of Washington.)

Die Leitgedanken. By E. Mach. Zwei Aufsatze. Pp. 31. (Leipzig: J. A. Barth.) 2 marks.

The Cambridge Pocket Diary, 1919–1920. Pp. xv+267. (Cambridge: At the University Press.) 2*s*. 6*d*. net.

The Thermionic Valve and its Developments in Radiotelegraphy and Telephony. By Prof. J. A. Fleming. Pp. xv+279. (London: The Wireless Press, Ltd.) 15*s*. net.

The Book of a Naturalist. By W. H. Hudson. Pp. viii+360. (London: Hodder and Stoughton.) 12*s*. net.

Birds in Town and Village. By W. H. Hudson. Pp. ix+274. (London: J. M. Dent and Sons, Ltd.) 10*s*. 6*d*. net.

A Popular Guide to the Wild Flowers of New South Wales. By F. Sulman. Vol. ii. Pp. xxxi+249+72 plates. (Sydney: Angus and Robertson, Ltd.) 6*s*. net.

Australian Wild Flowers. Photographed by A. E. Sulman. Second series. Pp. ii+61. (Sydney: Angus and Robertson, Ltd.) 1*s*. net.

Some Familiar Wild Flowers. Photographed by A. E. Sulman. Pp. ii+66. (Sydney: Angus and Robertson, Ltd.) 1*s*. net.

Das Erleben. By A. Koelsch. Pp. xi+389. (Berlin: S. Fischer.)

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College, and Papers in Elementary Engineering for Naval Cadetships, March to July. Edited by R. M. Milne. Pp. ii+40. (London: Macmillan and Co., Ltd.) 1*s*. 9*d*. net.

Science and Fruit Growing: Being an Account of the Results Obtained at the Woburn Experimental Fruit Farm since its Formation in 1894. By the Duke of Bedford and S. Pickering. Pp. xxii+351. (London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

Revision Arithmetic, Logarithms, Slide Rule, Mensuration, Specific Gravity and Density. By T. Thomas. Second edition. Pp. 62. (London: Crosby Lockwood and Son.) 2*s*. 6*d*.

DIARY OF SOCIETIES.

MONDAY, NOVEMBER 3.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—W. Brown: Sewer Ventilation and Health.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street, W.1), at 8.—Prof. J. Ward (President's Inaugural Address): In the Beginning . . .

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—C. A. Mitchell: Black Lead Pencils and their Pigments in Writing.—Capt. E. T. Sterne: Shawiningan Chemical Industries.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major K. Mason: Central Kurdistan.

TUESDAY, NOVEMBER 4.

ROYAL HORTICULTURAL SOCIETY (at London Scottish Drill Hall), at 3.—J. Snell: The Ormskirk Potato Trials.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—E. Heron Allen: Exhibition of Skiagraphs of Vermiculina from examples grown in a Hypertonic Tank.—Dr. G. Marshall: The Species of Balaninus occurring in Borneo (Coleoptera, Curculionidæ).—Miss J. B. Proctor: The Variation in the Number of Dorsal Scale-rows in our British Snakes.—G. A. Boulenger: Some New Fishes from near the West Coast of Lake Tanganyika.—The Hon. Paul Methuen: Description of a New Snake from the Transvaal together with a New Diagnosis and Key of the Genus Xenocalmus, and of some Batrachia from Madagascar.

MINERALOGICAL SOCIETY (Anniversary Meeting, at Geological Society), at 5.30.—Dr. W. R. Schoeller and A. R. Powell: Villamaninite, a New Mineral.—A. Russell: The Occurrence of Phenasite and Scheelite at Wheal Cock, St. Just, Cornwall.—L. J. Spencer: New Crystal-forms on Pyrites, Calcite, and Epidote.—Dr. G. F. H. Smith: A Curious Crystal from the Binnenthal.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Sir John Purser Griffith: Presidential Address.

RÖNTGEN SOCIETY (at the Medical Society of London), at 8.15.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—J. W. Simpson: Presidential Address.

WEDNESDAY, NOVEMBER 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—H. H. Thomas: Some Features in the Topography and Geological History of Palestine, Illustrated by Aeroplane Photographs taken during the War.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 8.—Dr. L. Aitchison: Valve Failures and Valve Steels in Internal Combustion Engines.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. R. Thompson: Egyptian Bricks.—A. R. Powell and Dr. W. R. Schoeller: The Analysis of Brazilian Zirconium Ore.—Ethel M. Taylor: The Halogen Absorption of Turpentine.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—*Probable Papers:* Dr. T. A. Chapman: (1) Contributions to the Life-history of *Lycæna euphemus*, Hb.; (2) Notes on *Lycæna aicon*, F.—Dr. G. D. H. Carpenter: Notes on Species of Pseudacræa from Uganda.

THURSDAY, NOVEMBER 6.

ROYAL SOCIETY (jointly with the ROYAL ASTRONOMICAL SOCIETY), at 4.30.—Sir Frank Dyson, Prof. Eddington, and Others: Discussion on the Results of the Observations obtained at the Total Solar Eclipse on May 29, 1919.

LINNEAN SOCIETY, at 5.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. A. P. Beddard: Some Remarks on Chronic Arthritis (Bradshaw Lecture).

CHEMICAL SOCIETY, at 8.

FRIDAY, NOVEMBER 7.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Committee), at 5.—Col. Sir S. G. Burrard, Prof. A. E. H. Love, and Others: Discussion on Isostasy.

TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—Prof. Baly: The Spectroscope in the Science of To-day.

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Editorial and Publishing Offices:
MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters to be addressed to the Publishers.

Editorial Communications to the Editor.
Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.